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Productivity optimization based on analytics of machine data and observations

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Agenda

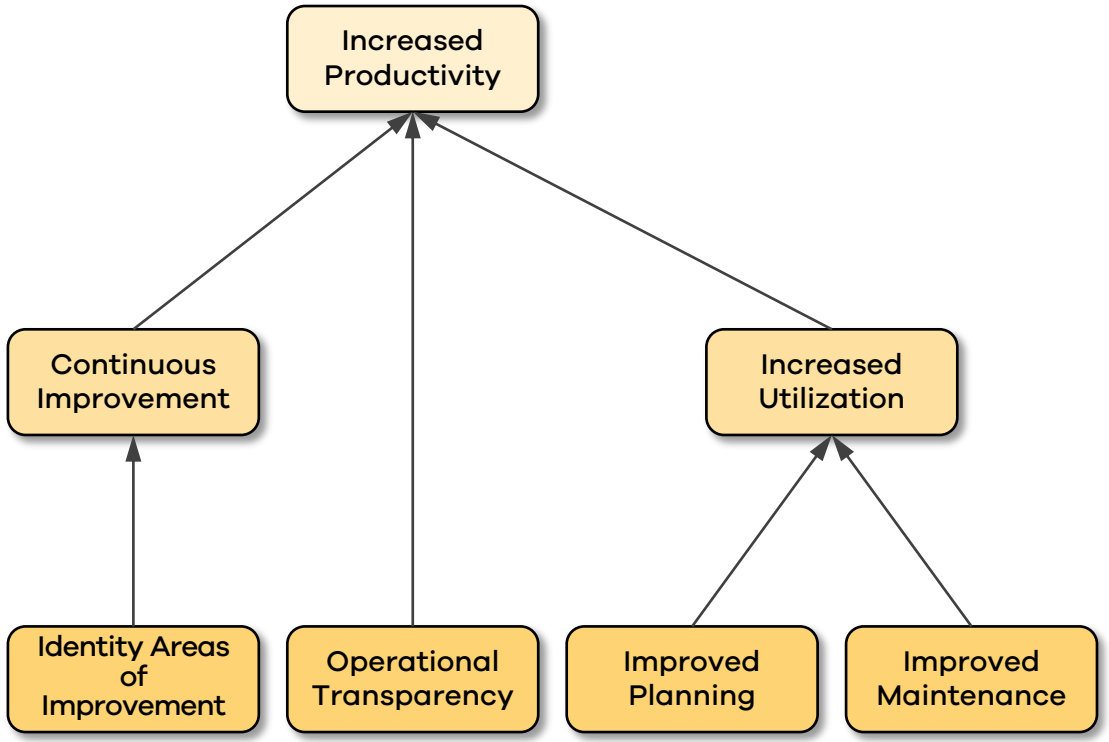
- Production Optimization Problems
- Key inputs for analytics
- How can data input help us solve optimization problems
- Utilization of Resources - TUM
- How to collect data into the TUM model
- How to analyze the TUM data
- Analytics Examples

Key factors to increase productivity

- Increase the overall-equipment-effectiveness
  - Improving ***equipment availability***
  - Raising utilization through better ***planning*** and ***scheduling***
- Embed effective management operating systems
  - Create greater transparency on ***operations performance*** and ***identify areas for improvement***
- Prioritize operational excellence and capabilities development
  - ***Continuous-improvement*** approach
  - Elimination of ***waste***, reducing ***variability***, and improving ***productivity of assets***
- Focus on innovation
  - ***Real-time data and better analytical engines*** are enhancing scheduling and processing approaches that can help maximize *equipment utilization*
  - Digitization also facilitates ***increased automation*** and ***mechanization***

Increased Productivity

- The process on how to reach a higher productivity can be modeled as an anatomy of sub-activities
- By starting with the goal and try to find a way how to reach it, we can get more focused meanwhile still be creative in the process
- Start to address questions to the project/organization



Examples of Production Optimization Problems

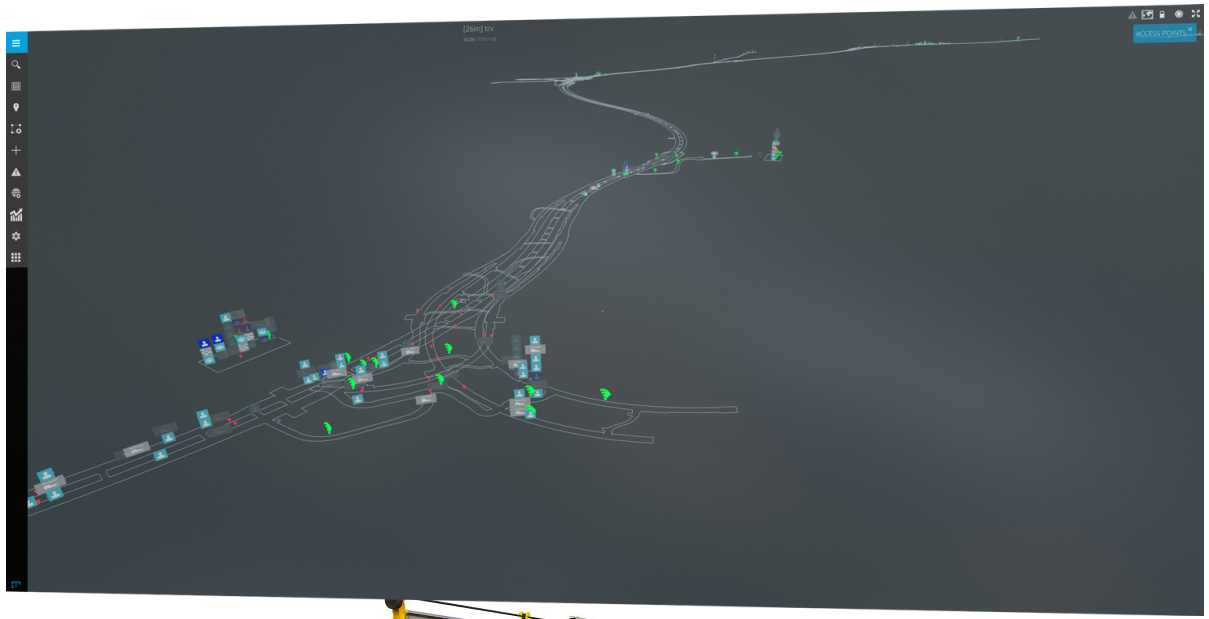
- What do we spend time on?
- How do we perform?
- How well do we plan?
- Machine Utilization?
- Face Utilization?
- Main reasons for Operating Delays?
- Main reasons for Equipment Breakdown?
- How much down time?
- How often are tasks delayed?
- Why are we late?
- Do we re-schedule?

Key inputs:
Source of information

- Human Observations
- Location Data
- Machine Data

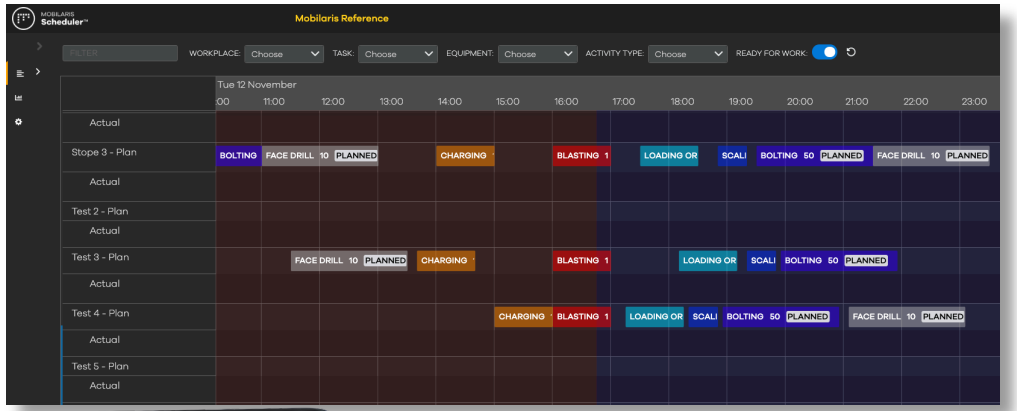
Input Using Digital Tools

Location



Machine Data

Planning tool



Dispatch Shift Activities

Report Actuals

Human Observations

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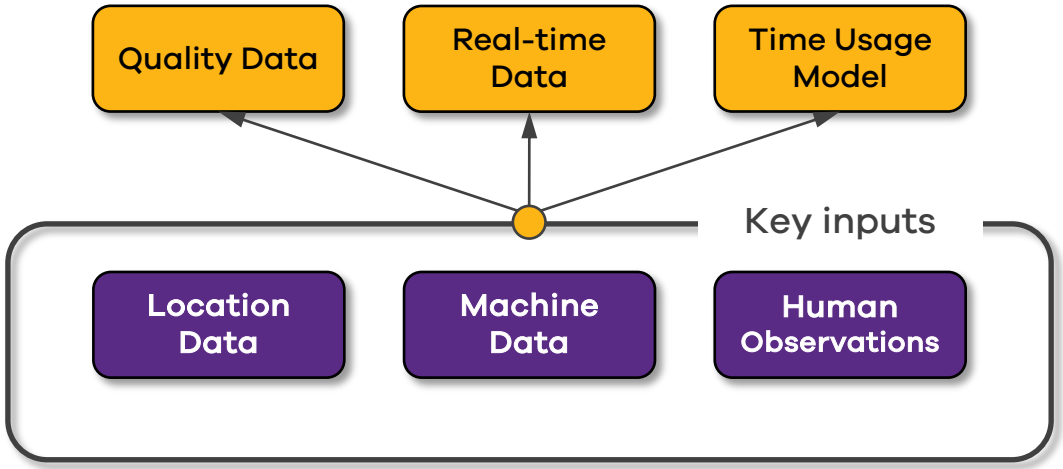
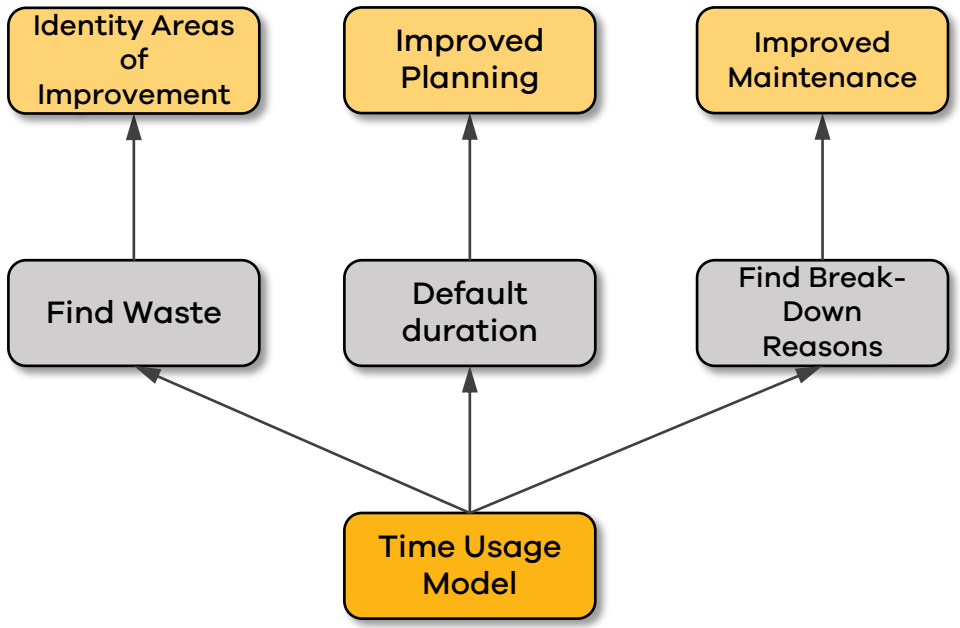
Anatomy

- The three key inputs forms the base of the anatomy:
  - **Location Data**
    - Draw point, dump point, face, parking lot, work-shop etc.
  - **Machine Data**
    - Speed, tonnage, drill meters, machine status, maintenance data
  - **Human Observations**
    - Hazards, check lists, interviews, quantity reporting
- The inputs will give possibility to:
  - Model time usage using a **Time Usage Model**
  - Get better **data quality**
  - Get data in **real-time**
- Human observations are very important, and can not all be replaced with machine data or AI



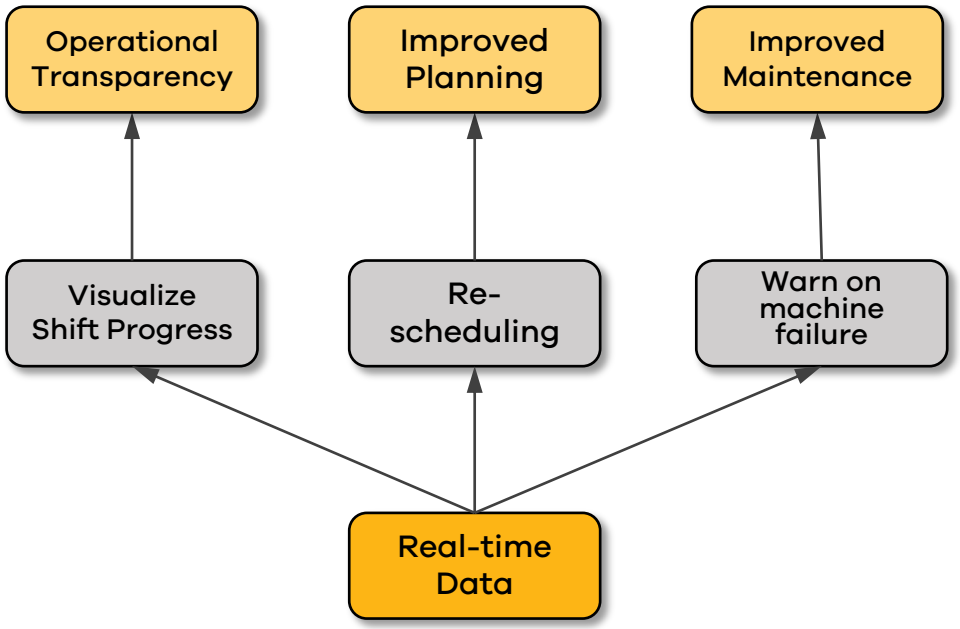
Anatomy – Time Usage Model

- **Find Time Waste (operating delays)**
  - Waiting for consumables
  - No electricity
  - Wait for operator
- Calculate **default duration** for a specific task
- Find reasons for **Machine Break-down**
- Find reasons for **Face/Workplace Delays**



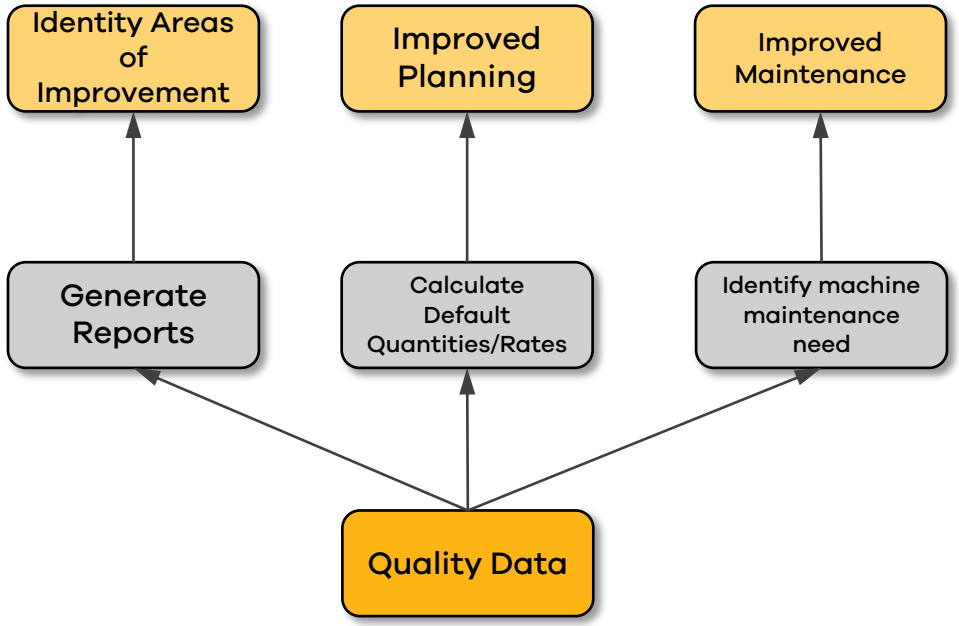
Anatomy – Real-time Data

- Real-time data will give the possibility to re-schedule when:
  - Planned tasks are late
  - Low progress rate
  - Machine break-down
  - Workplace problems (no electricity, water, hazards)
- Real-time data can be used to create **progress indicators** (KPIs) during the current shift



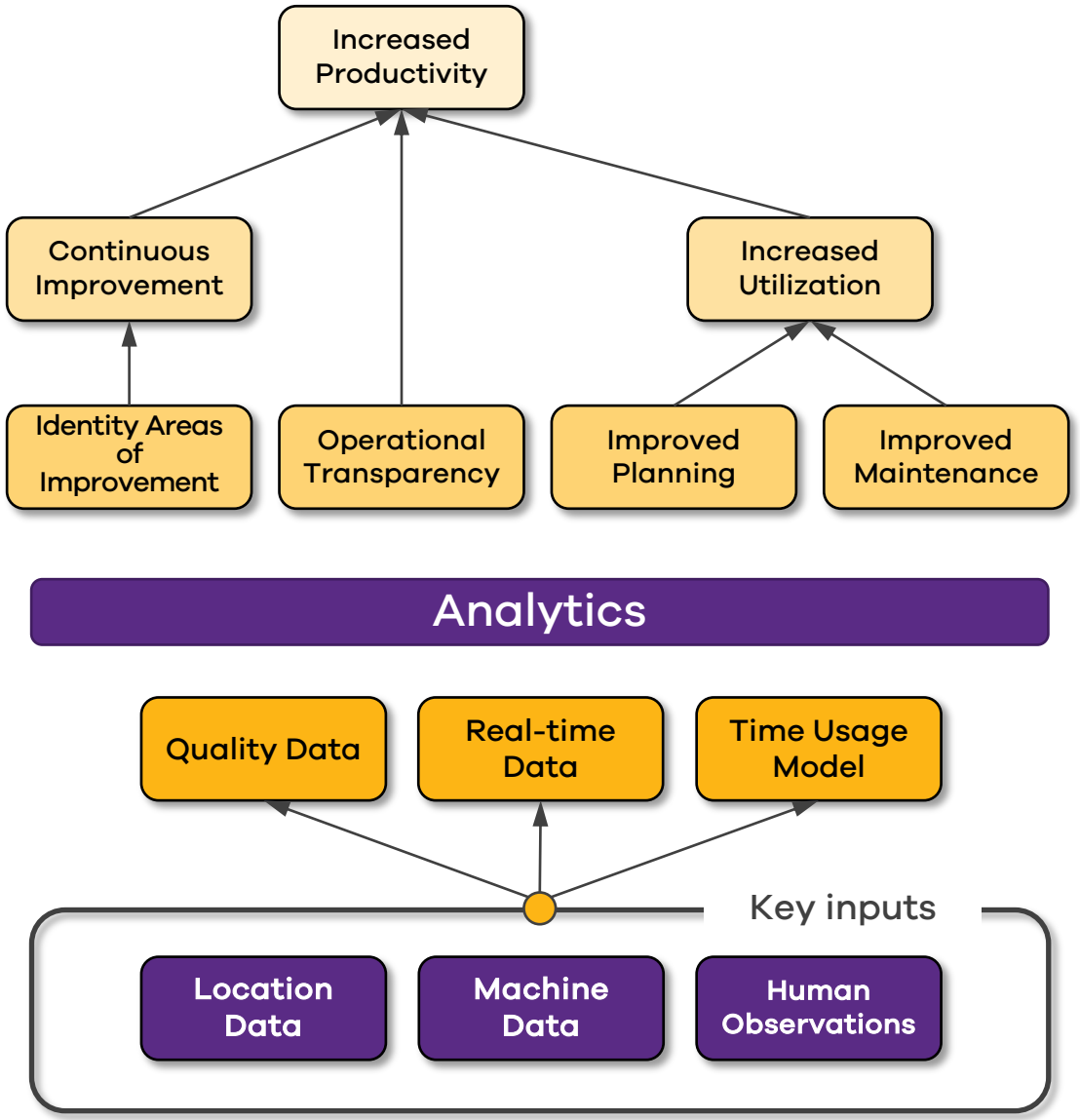
Anatomy – Quality Data

- More predictable measures for:
  - Analytics
  - Improved planning
  - Improved maintenance
- Calculate default number of quantities/rate for a specific task
- Generate reports automatically
  - Number of consumables
  - Number of tonnes
  - Number of drill meters
  - Measurement while drilling
- Gives valuable input to coming projects



Analytics

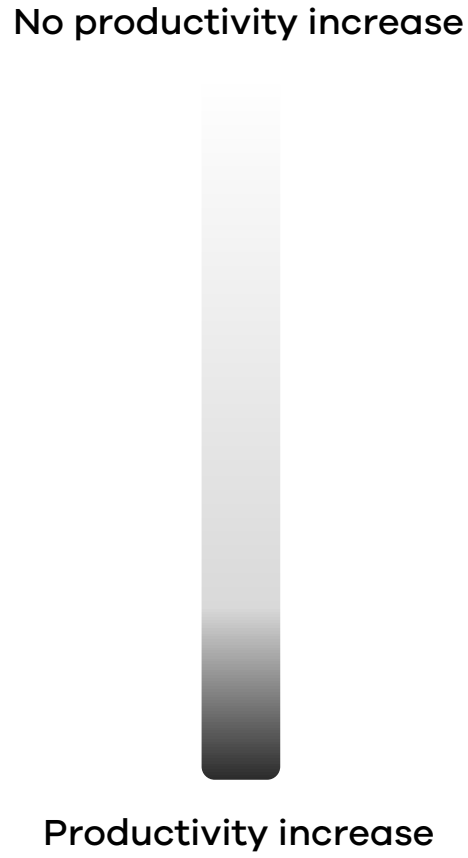
- By introducing an **analytics engine** to run during the shift, after the shift or periodically (daily, weekly, monthly) on data from the three key inputs it is possible to:
  - trigger actions
  - calculate performance measures
  - generate reports
  - learn from earlier experiences



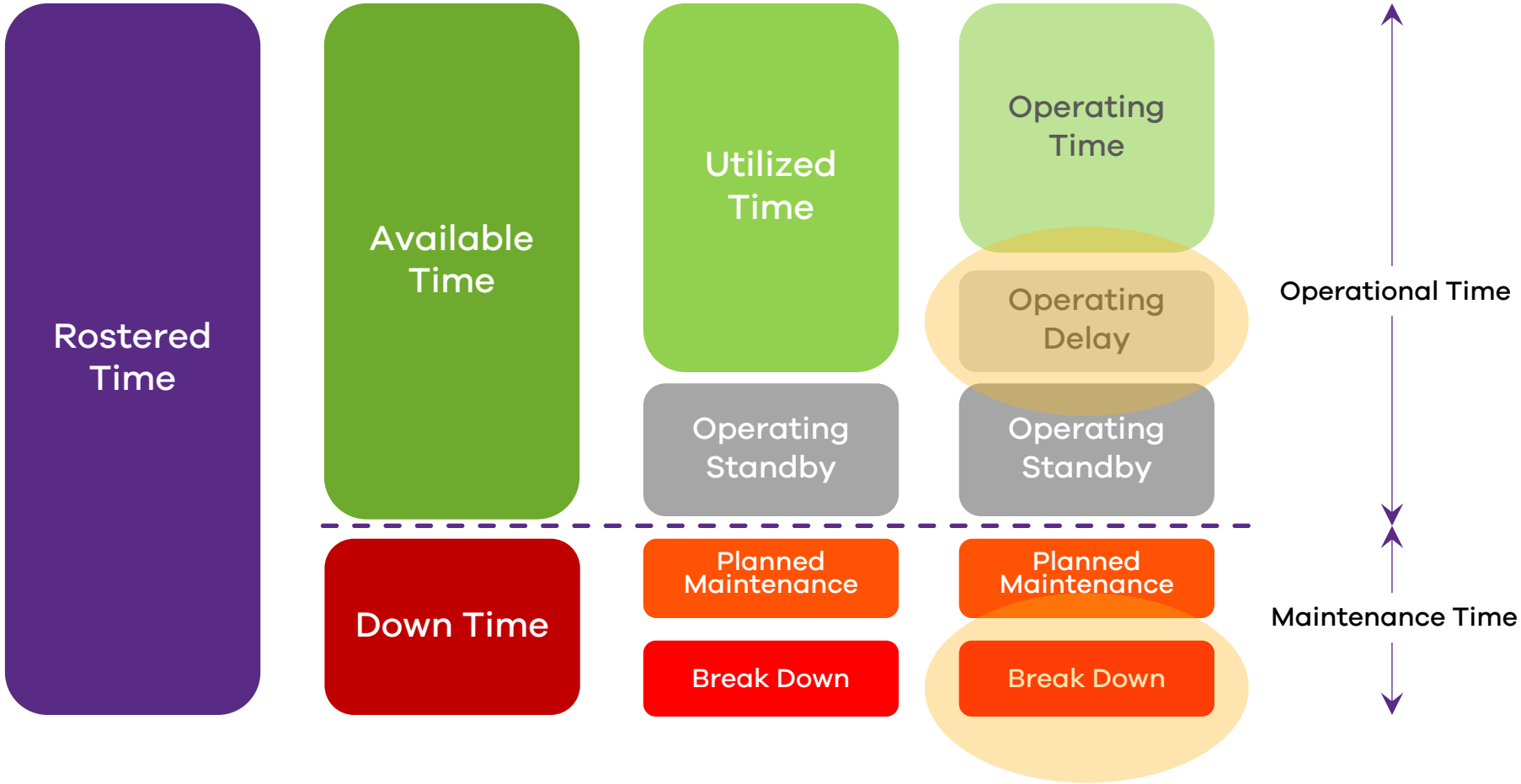
Observations from the industry

Observations from the industry

1. Collect Data from individual systems
   - Consider data quality
2. Gather data into integration platform
   - Consider data format
3. Generate Reports
4. Create KPIs based on durations and quantities
5. Analyze data to reduce variations
6. Analyze data to increase productivity



Time Usage Model – Equipment & Face



Fill the time buckets

Operating Time (OT)

- Start time
- Stop time
- Type of activity

Operating Delay (OD)

- Start time
- Stop time
- Reason
  - Wait for consumables
  - Wait for fuel
  - Wait for service
  - Wait for operator
  - Lunch break
  - Tramming
  - Setup time
  - Teardown time

Operating Standby (OS)

- **Lost opportunities**

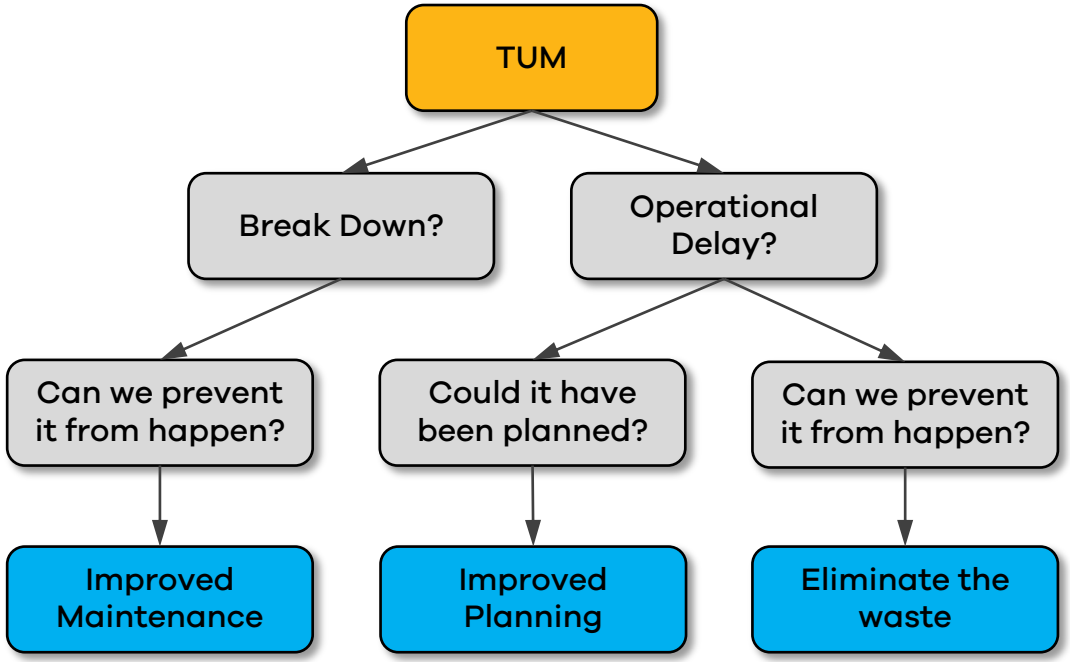
Planned Maintenance (PM)

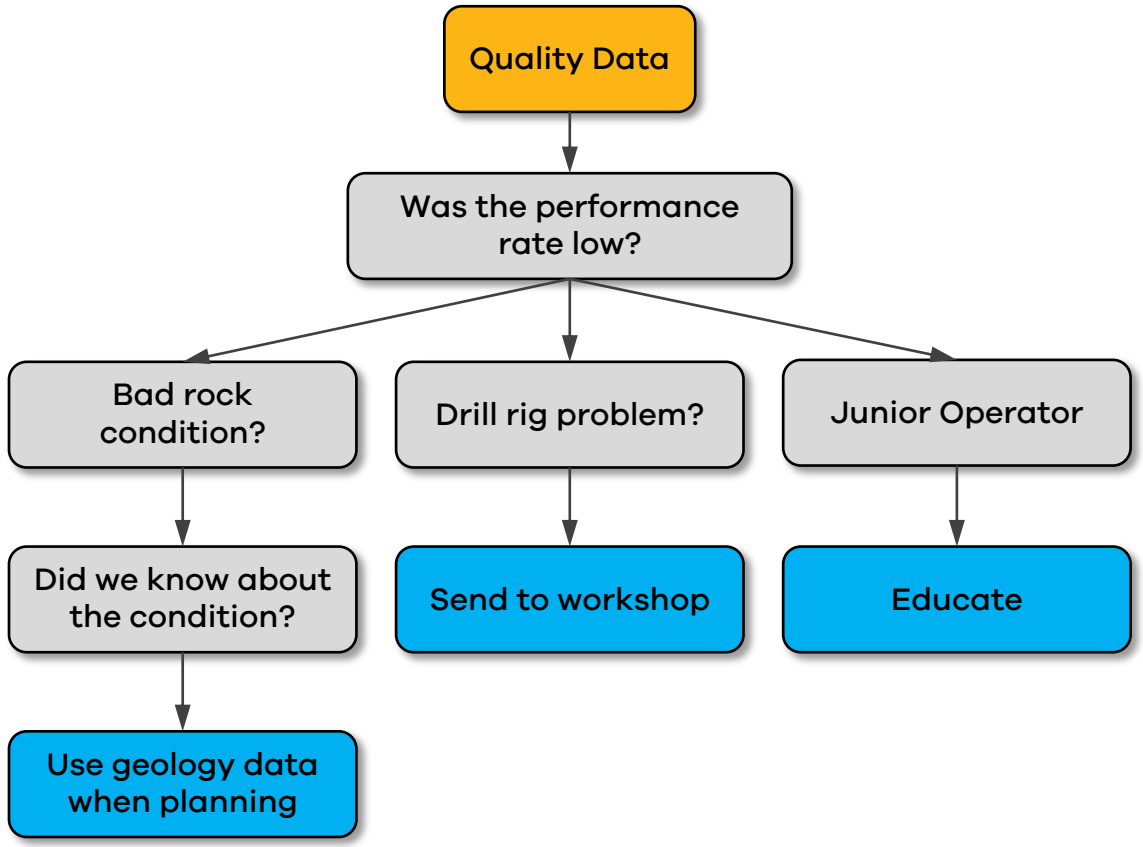
- Start time
- Stop time
- Reason

Break Down (BD)

- Start time
- Stop time
- Reason

Find the reasons to delays





Machine data for a Drill Rig – Use Case

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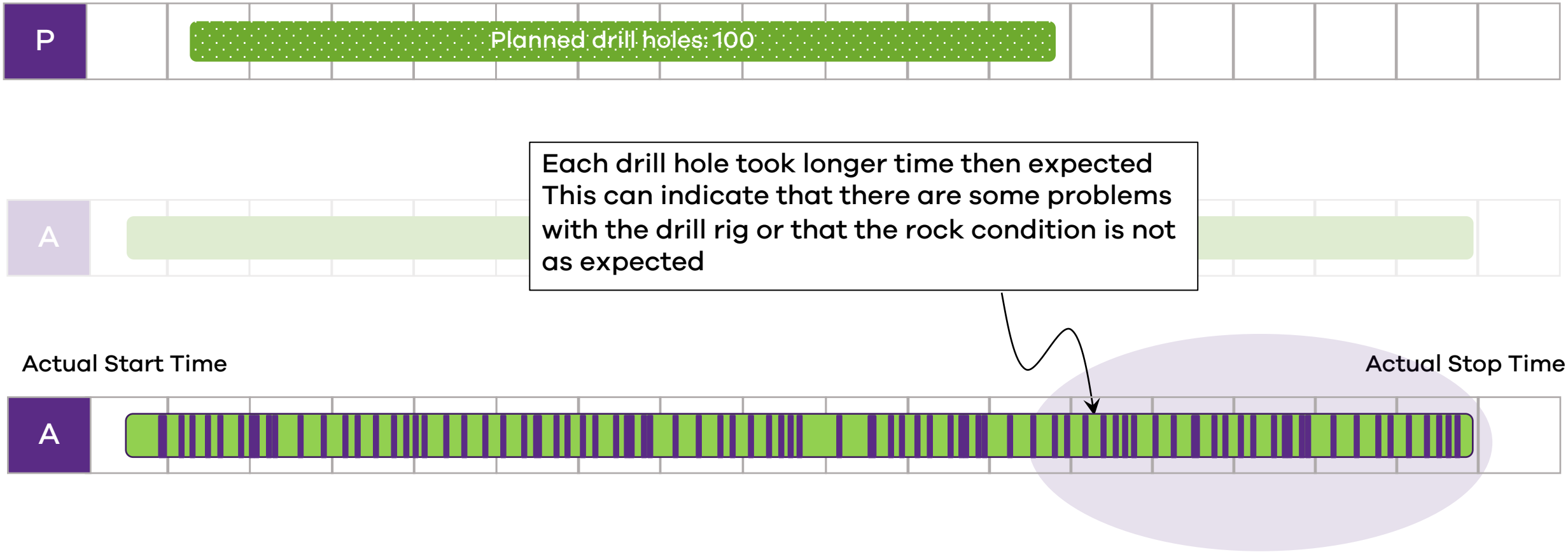
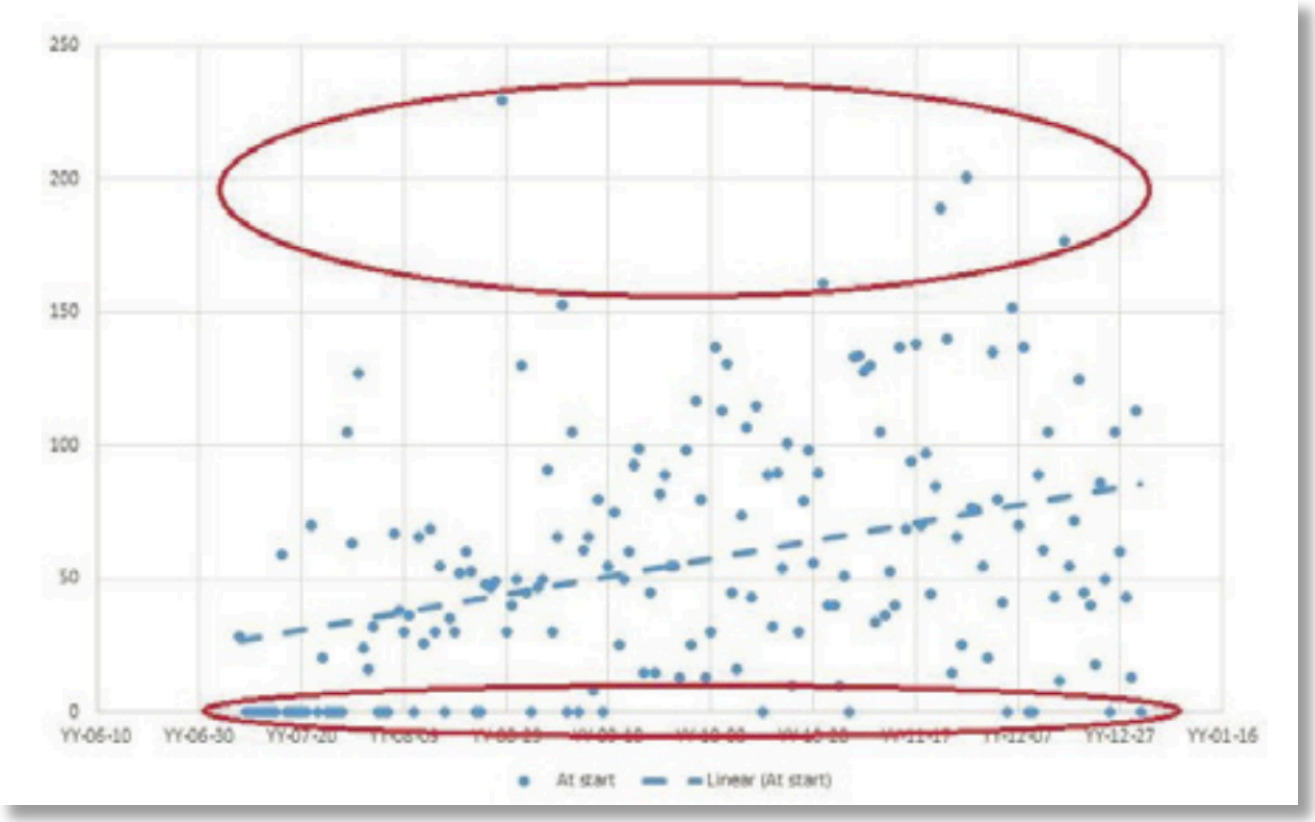


Analytics of bolting activities for Boliden

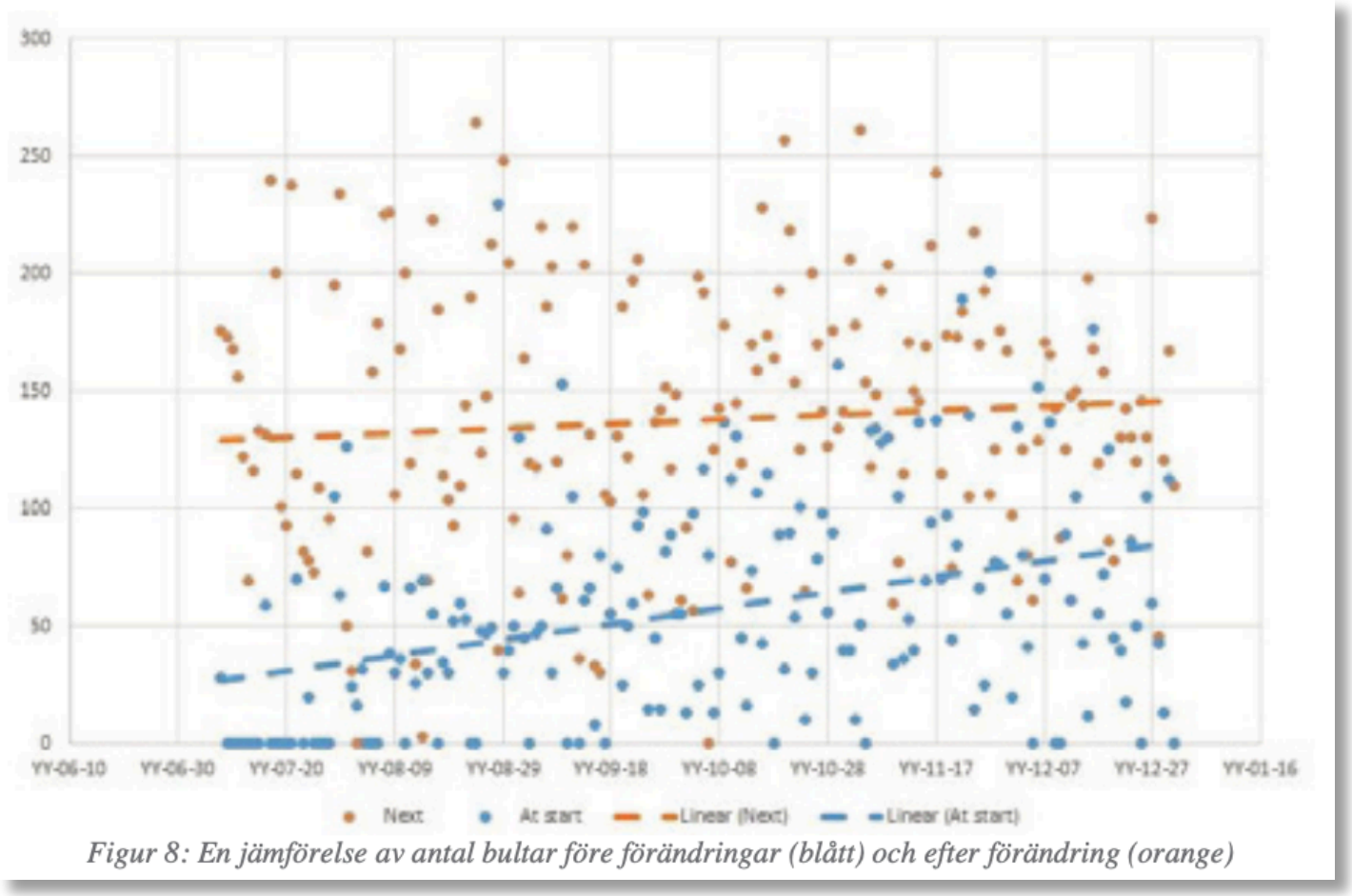
- Number of bolts per day
- Focusing on the outliers



Reasons and changes

Problem Area	Modifications
▪ Unnecessary tramming	▪ Better planning for tramming activities
▪ Overlapping bolts	▪ Introduction of BoltView
▪ Face not ready for work	▪ Better face maintenance
▪ Waiting on consumables	▪ Better planning on consumables, location of consumables
▪ Waiting on operator	▪ Better prioritization of operators

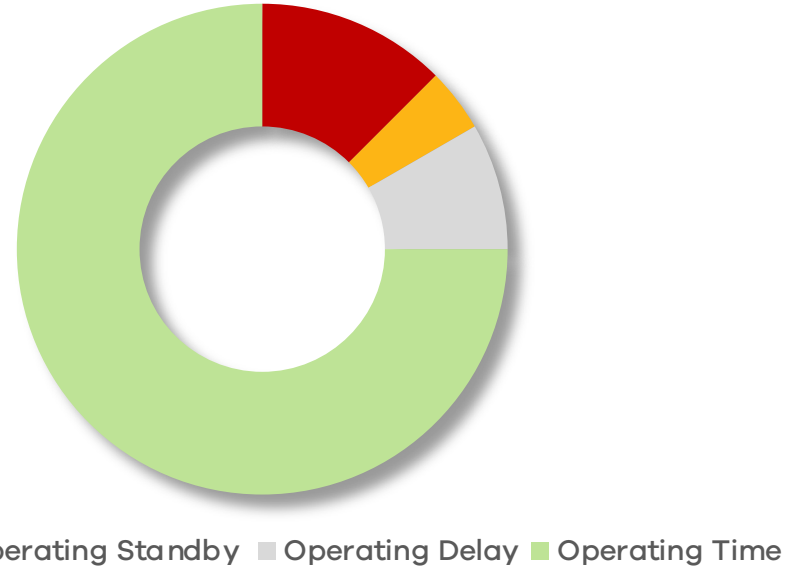
The result after implementing the changes



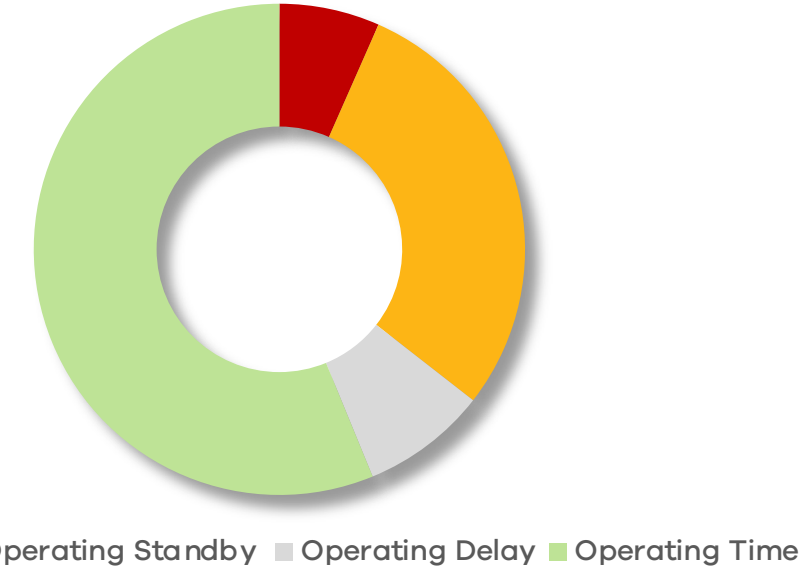
Figur 8: En jämförelse av antal bultar före förändringar (blått) och efter förändring (orange)

Utilization Diagrams

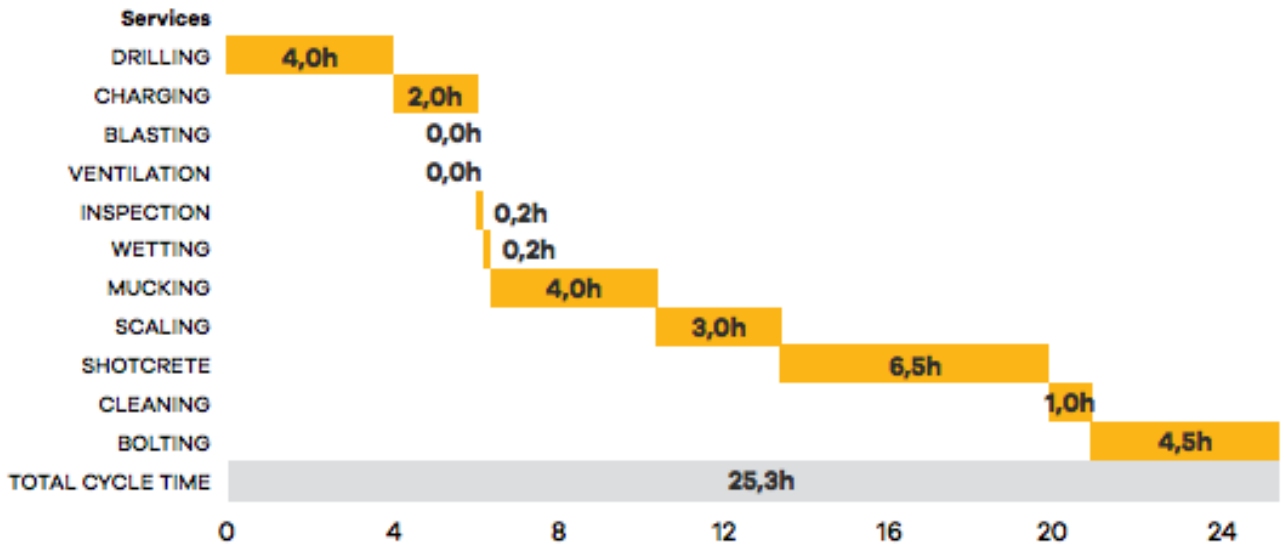
Equipment Utilization

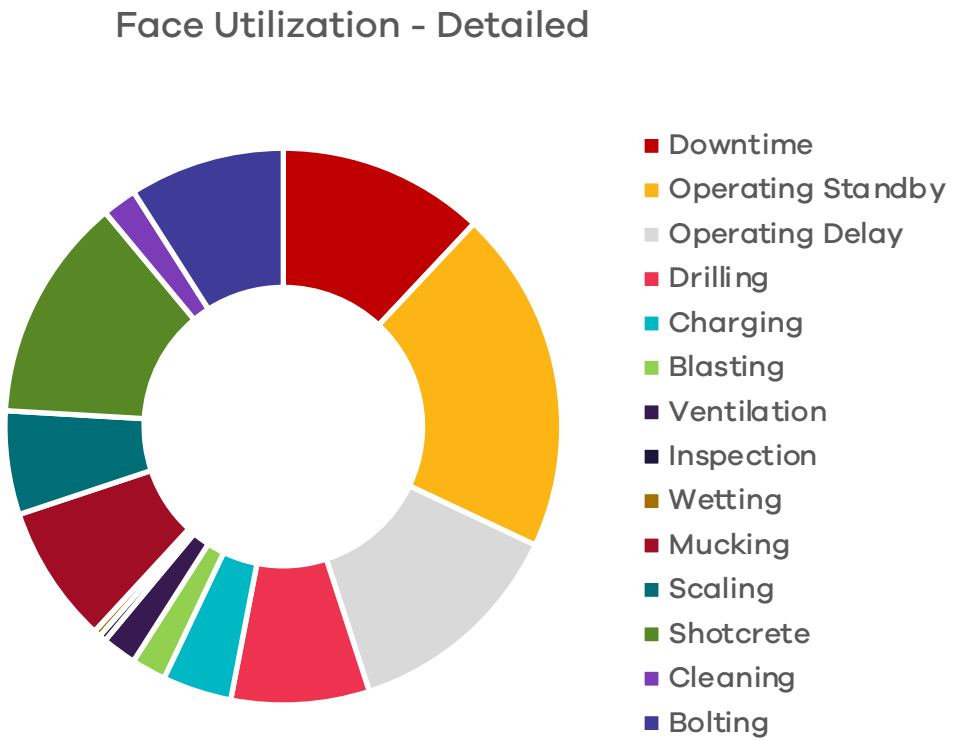


Face Utilization



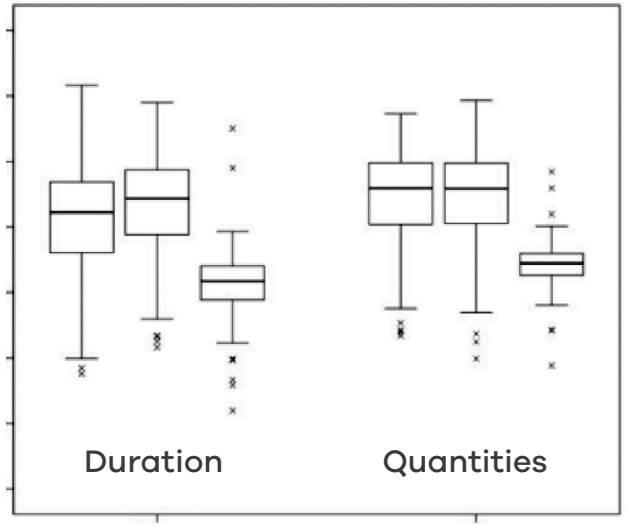
Detailed Face Utilization Diagram

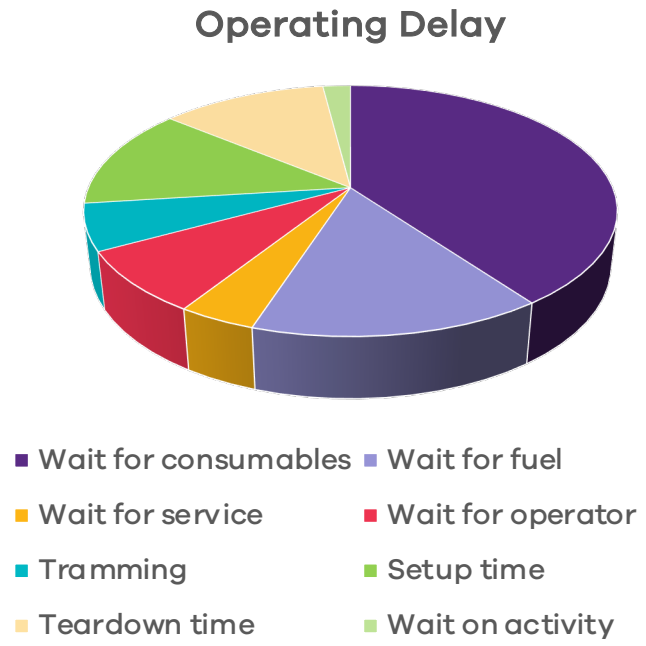




Analytics Examples

- Analytics on Operating Delays
- Analytics on Break Down
- Planned vs actual
  - Default duration on planned work tasks
  - Default rate
  - Default quantities
    - *Number of Drill Holes*
    - *Number of Bolts*
    - *Volume of Shotcrete*





This is the World of Mobilaris

A world where seeing is knowing. A world where access to data means being able to make better decisions faster. A world where you can predict and avoid undesirable situations. A world where both business and human concerns thrive in parallel.

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